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CERTAIN STRUCTURAL RESPONSES OF TWO MAIZE CVS. DIFFERing IN THEIR SALT TOLERANCE TO TRACE-ELEMENTS UNDER SALINE CONDITIONS

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ABSTRACT

The effects of both salinity at 2.5 dsm^{-1} and foliar application with some trace-elements, *i.e.*, Zn, Fe and Mn each alone or in combination on growth and anatomical structure of both roots and leaves of two maize cultivars differing in their salt tolerance were investigated. The role of the trace-elements on recovery the adverse effects of salinity was also studied.

Salinity at 2.5 dsm^{-1} significantly decreased plant height, leaf area (cm^2/plant), number and length of adventitious roots during the two growing seasons. The effects of salinity was more pronounced in salt sensitive cultivar, (two 310) than the other one. Under both salinized and non-salinized conditions, treatments with micronutrients each alone or in combinations not only increased all the above mentioned growth parameters compared with control, but also counteracted the harmful effects of salinity. Treatments with zinc alone or in combination were the most effective in this respect.

Anatomically, salinity decreased root diameter, exodermis thickness, cortex thickness, endodermal layer thickness and vascular cylinder diameter. In addition, salinity decreased thickness of the leaf in keel region, upper and lower epidermis and mesophyll tissue as well as large vascular bundle dimensions due to its effects on decreasing thickness of xylem and phloem tissues. Metaxylem vessel diameters were also decreased. Trace-element treatments each alone or in combinations increased all the above mentioned anatomical parameters. Treatment with zinc alone or in combination proved to be more effective in this respect.

It seems that, development of an extensive root system, formation of aerenchyma in the cortex tissue, early formation of exodermis play an important role not only in the adaptive mechanism to salinity but also in improvement plant tolerance to salinity.

Keywords: Maize, salinity, salt tolerance, trace elements, Zinc, Iron, Manganese, plant structure.

INTRODUCTION

Efforts have been made to increase the agricultural production to overcome the food gap by reclamation non-productive soils and/or using all sources of low quality water (El-quosy *et al.*, 1997).

Maize, *Zea mays* L., (Poaceae) is an economical important cereal crop in Egypt, when exposed to salt stress of various degrees under field conditions, plant growth and yield were reduced. The growth and productivity of corn, such as any plant species are limited by genotypes, and influenced by the environmental conditions.

Salinity is a major environmental constraint limiting the growth and yield of crop plants in many semi-arid and arid regions (Maggio *et al.*, 2001).Salt stress had greater deleterious effects on growth, morphology and anatomy of plant organs (Huang and Redmann, 1995). Adverse effects on plant growth and metabolism as a response to soil salinity are related with numerous structural changes including earlier occurrence of lignification, root aerenchyma formation and/or early development of large vacuoles (Reinhardt and Rost, 1995 a and b and Garicia *et al.*, 1997). They added that these anatomical features are usually considered to be adaptive to salinity. Schward *et al.* (1991) noted that plants may responded to form aerenchyma during salinity stress to compensate the reduction in metabolic activity due to salinity.

Trace-elements, especially Zn play an important role in adaptation to salinity stress through its effect on improving plant growth (Maggio *et al.*, 1997), enhancement vascular cylinder formation and preventing the distructural effect of salinity (Gadallah and Ramadan, 1997).

The objective of this investigation was to study the effects of both salinity and the fertilization with Zn, Fe and Mn each alone or in combination as foliar application on growth and anatomical structure of both root and leaf of two maize cultivars differed in their salt tolerance.

MATERIALS AND METHODS

A preliminary pot experiment was carried out in the greenhouse and laboratories of Agric. Botany Dept., Fac. of Agric., Mansoura Univ., to investigate the capability of the two corn cultivars to grow under different salinity levels, i.e., 2.5, 5.0 and 7.5 dsm-1. The main experiments were conducted according to the results obtained from the preliminary experiment including only low salinity level (2.5 dsm-1), since the two corn cvs. varied greatly in their response to the high salinity levels(5 and 7.5 dsm-1) levels and severe damage was recorded on cv. Two 310 (salt-sensitive cultivar), which failed to grow up till tasselling stage:

1- Plant material and experimental conditions:

Two pot experiments were carried out in the experimental farm and laboratories of Agric. Bot. Dept., Fac. of Agric., Mansoura Univ., Mansoura, Egypt, during the two growing seasons of 2002 and 2003. Each pot (40 cm diameter) was filled with 20 Kg of clean washed sandy soil.

2- Planting:

Uniform grains of the two cultivars of maize, C1 : Bachair 13 (salt-tolerant cultivar) and C2 : Two 310 (salt-sensitive cultivar) were obtained from the local hybrids which registered by Agricultural Research Center (ARC), Ministry of Agric., Egypt. The grains of both cultivars were sown (5 grains per pot) on the first June during the two growing seasons. The other agricultural practices were done according to those recommended by the Ministry of Agriculture. The pots were arranged in a complete randomized design with three replications. Each replicate contains 48 pots. After two weeks from sowing, the plants were thinned to leave only 2 uniform seedlings per pot.

The pots were divided into four groups as follows:

1- The first group, was not subjected to salinity and sprayed with distilled water (control plants).
2- The second group of plants was irrigated with artificial sea water at (2.5 dsm^{-1}).
3- The third group of plants was sprayed with trace-elements individually or in combination.

4- The fourth group of plants was irrigated with saline solutions and sprayed with trace-elements.

The salinization process was done one month before sowing in both seasons to reach the soil at equilibrium.

3- Trace-element treatments:

Plants were sprayed with either of foliated zinc 15 v. chelated (EDTA), or foliafeed chelated manganese 15% or folifeed chelated iron 13% at recommended doses (100, 100 and 80 ppm, respectively.
Spraying took place twice till dripping during the vegetative growth period (20 and 30 days from sowing. The trace-elements were applied each alone or in combinations.

4- Sampling dates and data recorded:

At tasseling growth stage (65 days from sowing) plant height (cm^2), number and length of adventitious roots were recorded as well as leaf area (cm2/plant) was calculated according to Quarrie and Jones (1979).

5- Anatomical studies:

For the anatomical studies, specimens (10mm) were taken from the basal part of an adventitious root formed on the first basal node and from the middle part (5 X 5 mm) of the 3rd leaf blade (including the keel region) from the plant tip of the two maize cultivars. Samples were fixed in FAA, 10% alcohol solution, dehydrated in ethyl alcohol series, cleared with xylene and embedded in paraffin wax (55-58°C-m.p.).
Cross sections (12-15 µm) thick were prepared by a rotary microtome, stained with saffranin-light green combination, cleared in clove oil and mounted in Canada balsam (Gerlach, 1977). Sections were examined microscopically.

5- Statistical analysis:

The data were statistically analyzed according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1- Growth and morphological characters:

1.1 Observation during growth:

Generally, the plants of the two cultivars were dwarfish and grown slowly under salinity as well as unhealthy in general appearance. Plants showed obvious changes in colour compared with the control plants, the rates of the leaf formation and leaf size were much reduced. The leaves of the two cultivars became dull coloured and often bluish-green. Plants of cultivar (2) failed to grow up to the tasseling stage at salinity level above 2.5 dSm^{-1}. However, the effect of salinity was more pronounced in cultivar (2) than cultivar (1) throughout the experimental period during the two growing seasons. Such symptoms may be attributed to disturbances in various metabolism processes (Muthukumarasamy and Panneerselvam, 1997).

Data in Tables (1 and 2) show that salinity at 2.5 dsm-1 significantly decreased plant height, leaf area (cm^2/plant), number and length of adventitious roots during the two growing seasons. The effects of salinity were more pronounced in the salt sensitive cultivar, Two 310 than the other one.

Table (1): Effects of salinity, trace elements and their interactions on plant height and number of adventitious roots during the two growing seasons of 2002 and 2003.

Salinity Levels dsm^{-1}	Trace-elements	Plant height (cm)				Leaf area (cm^2/plant)			
		Seasons							
		2002		2003		2002		2003	
		Cultivars							
		C1	C2	C1	C2	C1	C2	C1	C2
0	Control	124.9	108.1	125.3	108.5	103.1	94.8	103.4	98.5
	Zn	131.1	112.2	131.5	112.8	109.5	104.3	108.2	104.3
	Mn	126.8	109.2	127.6	109.6	104.7	95.9	104.6	101.6
	Fe	127.2	109.4	127.2	110.8	105.8	98.5	105.8	102.7
	Zn+Mn	131.0	110.3	131.8	113.6	112.6	107.7	110.4	110.9
	Zn+Fe	131.4	112.2	131.5	112.3	110.1	110.7	112.6	111.7
	Mn+Fe	127.4	113.2	127.5	109.9	107.6	99.6	109.9	110.5
	Zn+Mn+Fe	131.5	114.6	132.4	114.8	115.3	114.4	115.7	115.4
2-5	Control	122.0	98.2	119.8	98.8	101.4	84.4	99.9	89.5
	Zn	124.9	109.5	126.3	110.0	108.9	97.6	101.3	98.1
	Mn	123.3	106.8	124.9	107.5	103.6	98.3	101.1	103.4
	Fe	124.5	107.3	123.6	107.2	104.8	109.8	103.4	104.7
	Zn+Mn	127.2	111.2	127.7	112.8	111.6	107.2	109.8	105.5
	Zn+Fe	125.9	113.0	125.9	113.3	109.4	103.6	106.9	107.1
	Mn+Fe	123.7	109.8	122.3	109.9	106.6	99.2	106.4	107.3
	Zn+Mn+Fe	128.3	113.4	129.0	114.5	114.5	113.5	113.6	110.6
L.S.D at 5%		1.8		2.7		1.5		1.9	

C1: Salt tolerant cultivar; C2: Salt sensitive cultivar.

Data in the same Tables indicate that under salinized and non-salinized conditions, treatments with micronutrients Zn, Fe and Mn each alone or in combinations not only increased all the above mentioned growth parameters compared with control, but also counteracted the harmful effects of salinity. Treatment with Zn alone or in combination proved to be more effective in this respect.

The depressing effect of salinity on plant growth may be a result of an inhibition of cell division and cell elongation (Aspinall, 1986), and internal hormonal imbalance (Younis *et al.*, 2003). Sedik *et al.* (1998) noted that the disturbance in the mitotic activity under saline conditions may be due to reduction in the synthesis of nucleic acids or accelerating their degradation by increasing the activity of DNAase and RNAase. Moreover, the inhibition effect of salinity on plant growth may be attributed mainly to the osmotic stress, which reduced availability and uptake of both water and essential nutrients (Neumann, 1997), as well as an excessive accumulation of both toxic ions, *i.e.*, Na^+ and intermediate compounds such as reactive oxygen species (Rodriguez *et al.*, 2004), which reduced the metabolic activity (Schwarz *et al.*, 1991).

The enhancing effect of micronutrients on plant growth may be attributed to the important role of these elements in many physiological processes including, mineral uptake, photosynthesis and biosynthesis of plant hormones (Ahmed *et al.*, 2005). Furthermore, treatment with micronutrients correlated with the stimulation of antioxidant enzymes and enhanced the ability to remove active-oxygen species (AOS) by detoxification.The increase of antioxidant enzyme activities provides protection from oxidative damage induced by salinity (Yu and Rengel, 1999). In this respect, Smirnoff and Colombe (1988) concluded that, the detoxification of AOS is prime importance in any defense mechanism from the cytotoxic effects. In addition, Zn treatment improved the plant salt tolerance capacity through its promoting effect on IAA synthesis (Larcher, 1983) and increasing the absorbing surface through enhancement root elongation (Gadallah and Ramadan, 1997).

Table (2): Effects of salinity, trace elements and their interactions on number and length (cm) of adventitious roots during the two growing seasons of 2002 and 2003.

Salinity Levels dsm^{-1}	Trace-elements	No of adventitious roots/plant				Root length (cm)			
		Seasons							
		2002		2003		2002		2003	
		Cultivars							
		C1	C2	C1	C2	C1	C2	C1	C2
0	Control	13.0	10.0	13.0	11.0	22.9	18.7	34.5	19.3
	Zn	20.0	17.0	21.0	18.0	28.8	22.6	29.5	23.3
	Mn	15.0	13.0	15.0	13.0	23.4	20.1	35.3	20.4
	Fe	16.0	13.0	16.0	14.0	24.4	21.8	23.6	19.6
	Zn+Mn	20.0	18.0	22.0	18.0	30.0	24.2	30.6	24.6
	Zn+Fe	21.0	18.0	20.0	19.0	28.1	22.8	28.8	23.5
	Mn+Fe	16.0	14.0	17.0	17.0	26.2	21.8	27.5	22.4
	Zn+Mn+Fe	22.0	19.0	23.0	20.0	28.6	23.8	29.4	24.6
2-5	Control	09.0	08.0	10.0	10.0	17.5	16.3	18.0	16.8
	Zn	18.0	16.0	19.0	17.0	24.6	18.3	25.6	19.4
	Mn	14.0	11.0	14.0	12.0	19.6	16.3	20.2	18.1
	Fe	14.0	11.0	15.0	11.0	20.3	17.7	20.8	18.2
	Zn+Mn	19.0	16.0	20.0	17.0	25.6	21.2	27.3	21.5
	Zn+Fe	18.0	17.0	18.0	16.0	26.4	21.5	26.6	21.7
	Mn+Fe	15.0	14.0	16.0	12.0	25.2	17.5	24.3	19.1
	Zn+Mn+Fe	20.0	17.0	21.0	18.0	26.7	22.2	26.7	22.8
L.S.D.		0.9		1.3		0.3		0.2	

C1: Salt tolerant cultivar; C2: Salt sensitive cultivar.

2- Anatomical structure:

2.A. Root structure:

Data presented in Tables (3 and 4) and illustrated in Figs. (1B and 3B) show that salinity decreased root diameter, exodermis thickness, cortex thickness, endodermal layer thickness and vascular cylinder diameter. Metaxylem vessel number and its diameter were also decreased.

On the other hand, treatments with micro-elements each alone or in combination increased all the above mentioned anatomical parameters. It was found that treatments with Zn alone (Fig. 1C and 3C) or in combination with other micro-elements (Fig. 1D and 3E) were the most effective in this respect.

The results show also that salinity treatment associated with visible anatomical changes in the adventitious root structure in both maize cultivars compared with the control. The responses of both cultivars to salinity varied greatly and depended on their salt capacity. These anatomical changes were more pronounced in Two 310 (salt sensitive cultivar). The most remarkable anatomical features of sensitive cultivar under saline conditions are, distortion of epidermis and cortex cells as well as metaxylem vessels with damaged pith tissue. Moreover, no exodermis was differentiated. A lateral root initiation from the pericycle layer was also observed (Fig. 3B). While, the roots of tolerant plants showed precocious suberization and/or lignification of the exodermal and endodermal cells (Reinoso *et al.*, 2004) as well as early formation of internal air spaces (aerenchyma) in the cortex tissue and well developed exodermis (Fig. 1B). It could be suggested that plants may be try to form aerenchyma during NaCl stress to compensate a reduction in metabolic activity due to salinity (Schwarz *et al.*, 1991). It has been suggested by other authors (Reinhardt and Rost, 1995a and Garica *et al.*, 1997) that formation of aerenchyma and/or vacuoles is an adaptive responses that contributes to protect the cytoplasm from toxic ion levels by storing them. Moreover, an exodermis differentiation in salt tolerant cultivar under saline condition may play an important role in protecting the root from water loss and/or leakage of solutes important for adjustment (Reinhardt and Rost, 1995b). They added that the endodermis is considered to be the major constraint for movement of solutes ftom the vascular tissues due to the impregnation of its walls with hydrophobic substances. Serrato-Valenti *et al.* (1996) noted that the adaptation to saline stress was adjusted with increasing the lignifications process.

The promoting effect of salinity on aerenchyma formation may be attributed to an increase in ethylene production. It enhanced cell wall degradation by promoting the activity of cellulose and polygalactourinase (Hung *et al.*, 1997).

Under saline conditions, the most notable responses of the tolerant cultivar to micro-elements, especially Zn were an enhancement and formation of aerenchyma in the cortex region (Fig. 2B)and lateral root differentiation (Fig. 2B). Another important response to micro-element treatment, is an enhancement of xylem formation. It is evident from (Fig. 2A) that, under saline conditions, treatment with Zn enhanced the development of xylem in pith tissue. The formation of aerenchyma in the cortex tissue and development of an extensive root system is another adaptive mechanism to salinity.

The reduction effects of salinity on the adventitious root structure may be attributed to its effects on inhibiting cell division and cell enlargement (Aspinall, 1996).

The beneficial effects of micro-elements, mainly, Zn, on root structure may be attributed not only to its role in increasing root growth through enhancement root elongation, xylem formation and protected xylem distructure by salinity (Gadallah and Ramadan, 1997), but also through enhancement the formation of both aerenchyma and lateral roots (Fig. 2).

Anatomically, it could be concluded that salinity tolerance in (Bachaier 13) is associated with the formation of aerenchyma in cortex tissue as well as development of both exodermis and thickened endodermis. Such anatomical modifications were obtained with micro-elements treatments.

Data in Table (4) and illustrated in Figs. (4 and 5) show that salinity decreased each leaf thickness in the keel region thickness of upper and lower epidermis, mesophyll tissue thickness and large vascular bundle dimensions due to its effects on decreasing thickness of xylem and phloem tissues. Metaxylem vessel diameters were also decreased in the two corn cultivars. Trace-element treatments each alone or in combination not only increased all the above mentioned anatomical parameters but also counteracted the harmful effects of salinity in the two corn cultivars. Treatments with Zn alone or in combination proved to be more effective in this respect.

Table(3). Some anatomical measurements (µm) of the adventitious roots formed in the first basal node as affected by salinity, trace elements and their interactions during the second season of 2003.

Salinity levels	Treatments	Characteristics													
		Root diameter		Exodermal thickness		Cortex thickness		Endodermal layer thickness		Vasculor cylinder diameter		No of metaxylem vessels		M.X. vessel diameter	
		Cultivars													
		C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
0	Control	1204	1074	78	24	440	360	14	10	750	700	14	13	96	76
	Zn	1544	1252	92	44	560	480	22	14	970	760	26	16	132	92
	Mn	1352	1180	80	36	500	430	17	12	840	740	20	14	112	80
	Fe	1216	1214	88	40	520	466	15	13	864	735	21	15	120	84
	Zn+Mn	1380	1226	84	36	508	470	16	15	860	748	22	14	124	88
	Zn+Fe	1392	1210	90	39	490	442	18	17	884	756	21	15	124	88
	Mn+Fe	1305	1144	82	30	420	400	17	18	870	730	18	14	122	82
	Zn+Mn+Fe	1610	1390	94	58	580	560	20	20	1010	810	28	17	140	96
2.5	Control	1145	940	72	-	410	300	14	-	720	630	12	12	90	64
	Zn	1420	1098	98	62	490	380	18	15	900	710	22	14	12	88
	Mn	1250	1090	84	52	430	364	16	14	810	720	16	12	100	74
	Fe	1315	1116	86	56	460	380	14	13	840	724	18	13	105	78
	Zn+Mn	1340	1145	92	60	510	394	15	12	810	740	18	15	112	82
	Zn+Fe	1410	1115	88	66	520	374	19	12	870	724	16	16	116	84
	Mn+Fe	1400	1100	90	64	510	360	17	13	878	730	15	14	114	80
	Zn+Mn+Fe	1740	1310	120	74	720	500	28	18	990	790	24	16	128	92
L.S.D at 5%		48		5.0		15		3.0		22		3		6	

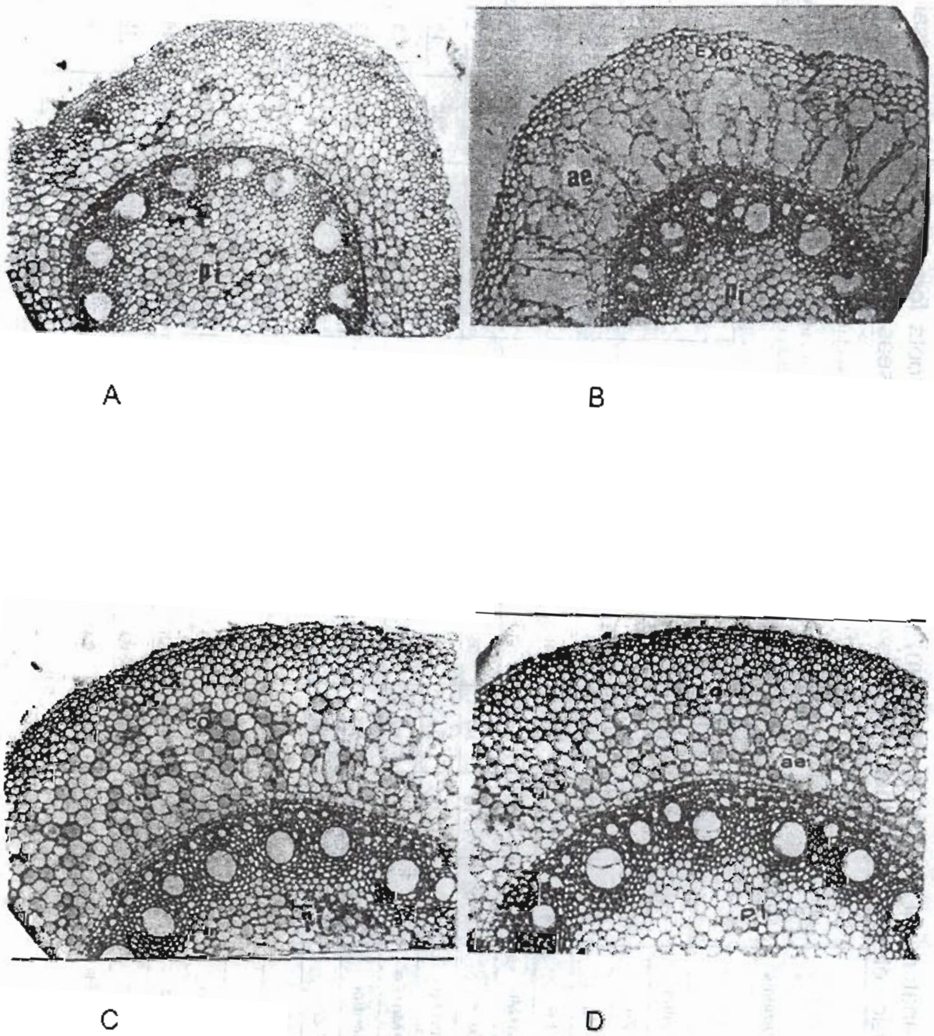

Fig.(1): Cross sections of the adventitious roots taken from salinity tolerant maize cultivar (Bachaier 13) as affected by salinity and trace-elements (obj-x10-oc-x10)

A:control B: Salinity C:Zn D:Zn+Mn+Fe Exo:exodermis
Co:Cortex End:Endodermis Pi:Pith MX:metaxylem vessel

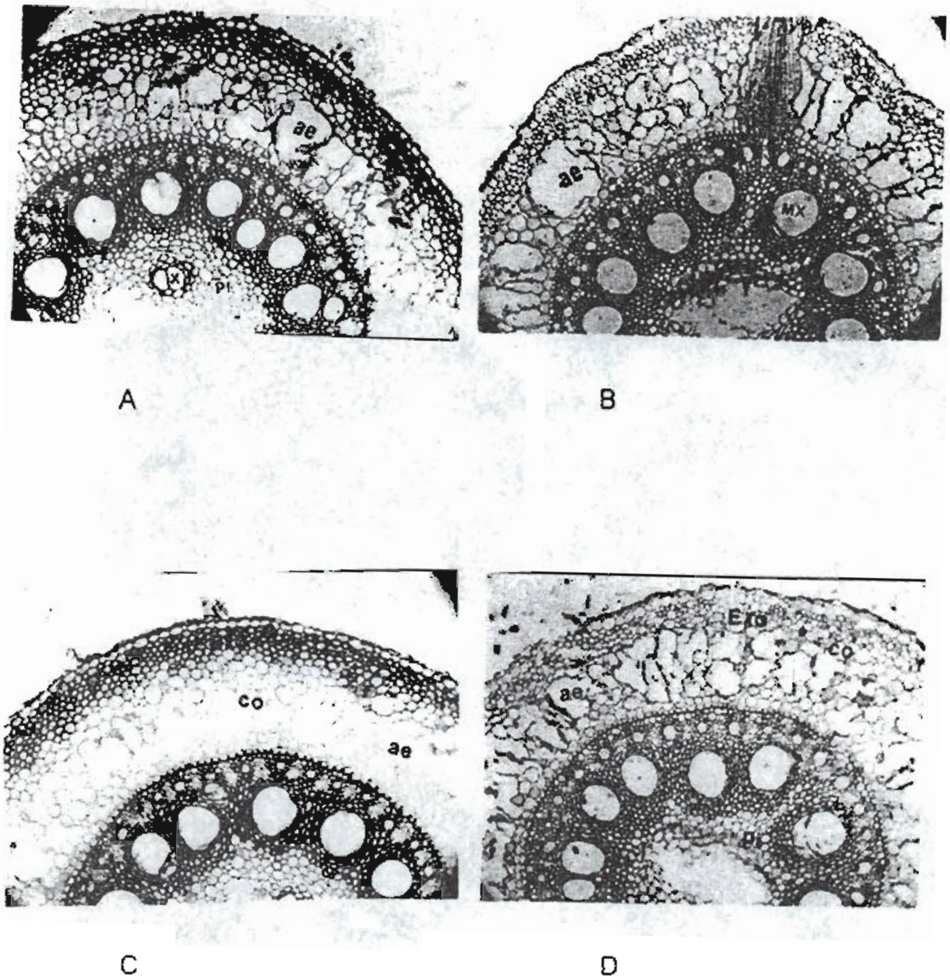

Fig.(2): Cross sections of the adventitious roots taken from salinity tolerant maize cultivar (Bachaier 13) as affected by salinity and trace-elements under saline conditions showing formation of aerenchyma in the cortex, development of xylem in pith as well as development of lateral roots (obj-x10-oc-x10)

A+B: Salinity+ Zn C+D: Salinity + (Zn+Mn+Fe)

Ae:aerenchyma LR:lateral roots

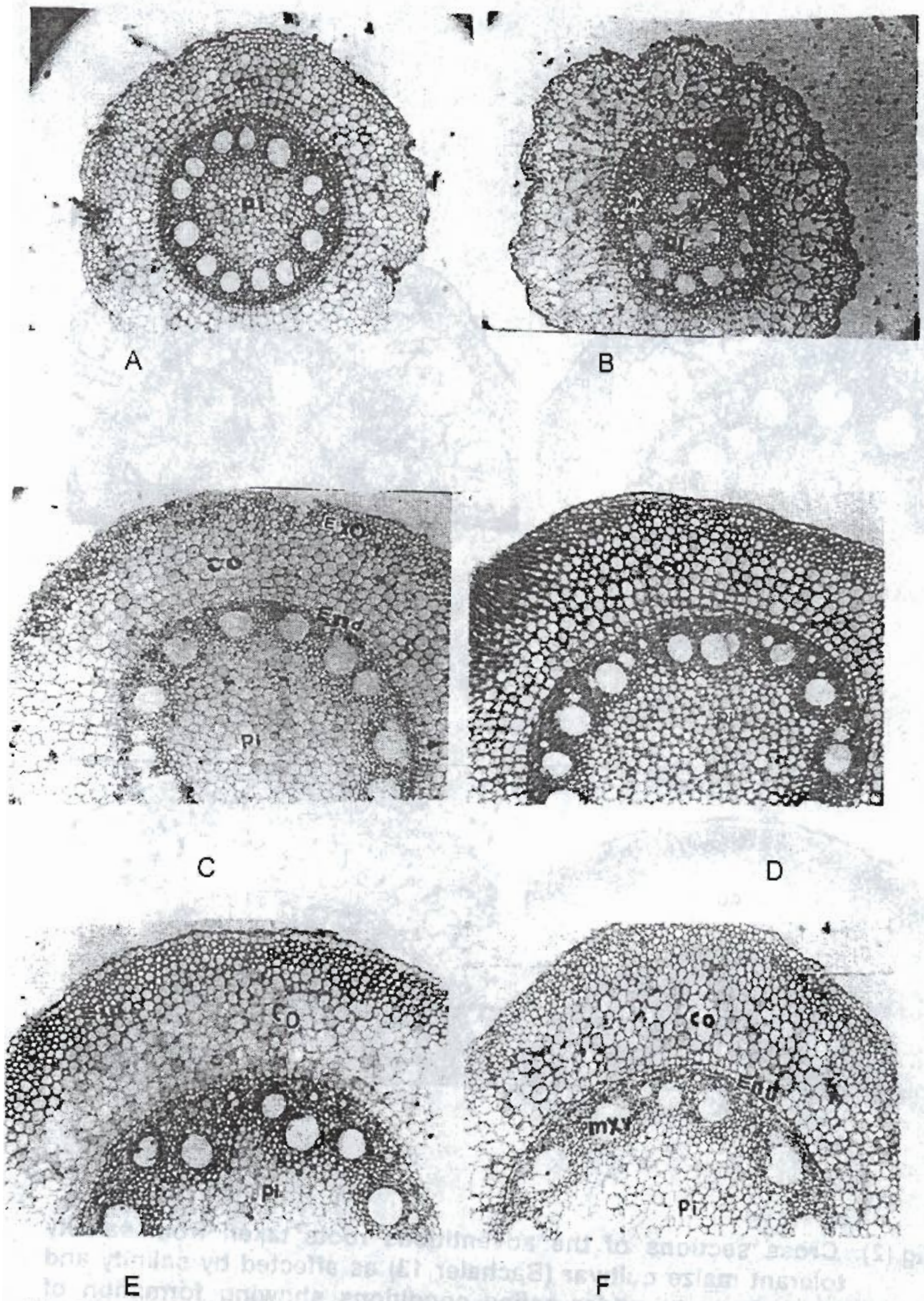

Fig.(3): Cross sections of the adventitious roots taken from salinity sensitive maize cultivar (TWC 310) as affected by salinity and trace-elements and their interactions (obj-x10-oc-x10)

A:control B: Salinity C:Zn D: salinity+ Zn E:Zn+Mn+Fe F: salinity + (Zn+Mn+Fe)

Table(4) Some anatomical measurements (µm) of the 3rd leaf from the plant tip at tasseling stage as affected by salinity, trace elements and their interactions during the second season of 2003.

Salinity levels	Treatments	Leaf thickness		Upper epidermis thickness		Lower epidermis thickness		Mesophyll tissue thickness		L.V.B. dimension				Xylem tissue thickness		Phloem tissue thickness		M.X. vessel diameter	
										Length		Width							
		C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
	control	610	580	13.0	10.1	16.0	11.0	581	559	98	84	140	132	60	48	38	36	34	30
	Zn	780	740	21.0	18.4	28.0	13.6	732	708	152	114	170	148	84	68	68	46	44	38
	Mn	670	630	18.0	16.3	22.0	11.7	630	602	128	100	156	138	76	60	52	40	38	34
	Fe	694	670	19.1	17.1	24.1	12.8	651	640	128	106	164	142	72	64	56	42	40	34
	Zn+Mn	788	710	13.7	18.1	23.3	12.1	746	680	141	112	168	146	80	68	61	44	38	36
	Zn+Fe	824	720	18.5	17.5	23.5	13.1	768	670	142	108	160	138	84	66	58	42	42	38
	Mn+Fe	810	700	20.5	18.4	25.5	15.3	778	686	149	114	170	144	84	68	65	46	46	42
	Zn+Mn+Fe	840	810	24.0	20.7	36.0	16.0	786	774	160	124	172	150	88	72	72	52	56	50
2.5	Control	540	510	19.3	2.2	13.7	8.0	497	454	92	74	136	118	48	42	44	32	28	24
	Zn	730	560	18.8	10.5	27.2	11.5	684	538	144	108	158	136	80	64	64	44	40	34
	Mn	650	600	17.1	10.0	21.0	9.2	612	581	118	94	148	124	72	58	46	36	34	30
	Fe	670	664	18.5	11.0	22.5	11.1	629	692	124	100	152	128	76	58	48	42	38	34
	Zn+Mn	665	690	19.0	12.0	21.0	12.7	625	665	128	106	154	134	74	66	54	40	40	32
	Zn+Fe	658	655	17.9	11.5	21.1	12.3	619	630	130	102	154	138	78	64	52	38	42	36
	Mn+Fe	690	678	20.5	12.3	23.5	12.0	646	654	140	104	158	140	82	62	58	42	38	34
	Zn+Mn+Fe	835	770	22.5	13.5	33.5	14.9	789	742	152	116	160	144	84	68	68	48	48	38
L.S.D. at 5%		30.0		2.1		3.5		18.0		9.0		8.0		3.0		3.0		4.0	

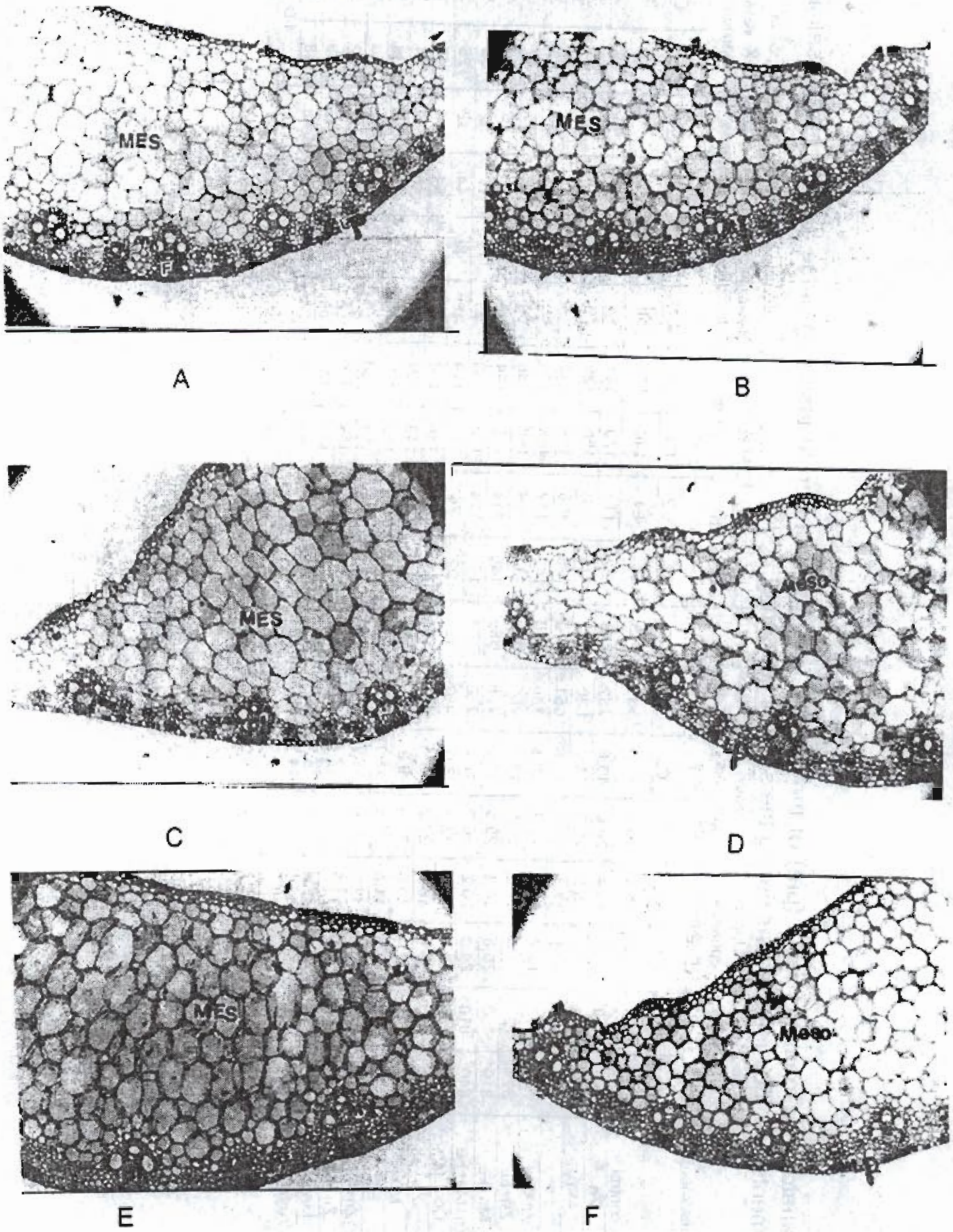

Fig.(4): Cross sections of the 3rd leaf blade from the plant tip of salinity tolerant maize cultivars (Bachaier 13) as affected by salinity, trace elements and their interactions (obj-x10-oc-x10)
A:control B: Salinity C:Zn D:salinity+Zn E:(Zn+Mn+Fe)
F: Salinity+(Zn+Mn+Fe) up: upper epidermis Lp:Lower pidermis
Mes: Mesophyll tissue Ph: Phloem Mx: Metaxylem vessel

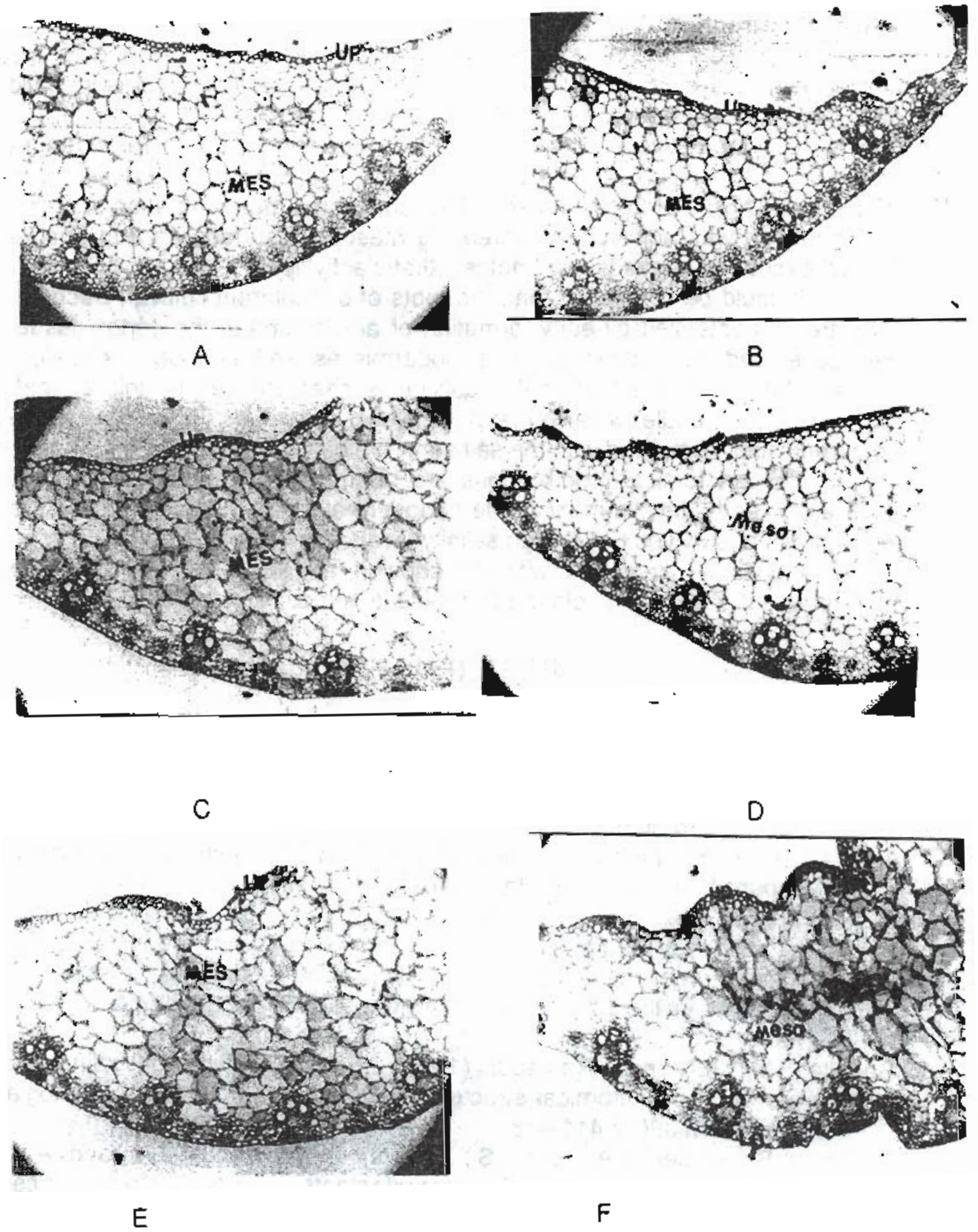

Fig.(5): Cross sections of the 3rd leaf blade from the plant tip of salinity sensitive maize cultivars (TWC 310) as affected by salinity, trace elements and their interactions (obj-x10-oc-x10)

A:control B: Salinity C:Zn

D: salinity+Zn E:(Zn+Mn+Fe) F: Salinity+(Zn+Mn+Fe)

2- B. Leaf structure:

The reduction in leaf thickness under salinity may be due to the decrease in cell division as a result of nuclear degradation of meristimatic cells (Katsuhara and Kawaski, 1996).

The promotive effects of trace-element treatments on leaf structure may be due to an increase in leaf thickness and vascular bundle dimensions (FigS. 4 AND 5). Jafri and Ahmad (1995) concluded that adaptation to saline environments was adjusted by increasing mesophyll surface area to ensure normal exchange of gases and photosynthetic activities.

It could be concluded that, the roots of salt tolerant cultivar, Bachaier (13) are characterized by early formation of aerenchma in the cortex tissue, well developed an exodermis and endodermis as well as wider metaxylem vessel. Moreover, the leaf of this cultivar is characterized by thicker leaf, larger vascular bundle, wider metaxylem vessel as well as thicker xylem and phloem tissues compared with the salt sensitive cultivar, Two 310.

The anatomical modifications are related to metabolic adaptations, such as an early development of the endodermal barrier for ion exclusion to allow plants to survivae under high salinity levels (Reinosa *et al.*, 2004).

Generally, treatment with Zn showed an ability to overcome the harmful effect of salinity on plant growth and its structure.

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إستجابات التركيبية لصنفين من الذرة الشامية مختلفين فى قدرتهما علــى تحمــل الملوحة للعناصر الصغرى تحت ظروف الملوحة

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تم دراسة تأثير كل من الملوحة وبعض العناصر الصغرى مثل الزنك والمنجنيز والحديد بصورة منفردة أو متداخلة على النمو والتركيب التشريحى للجذور والأوراق لصنفين مــن الــذرة الشامية مختلفة فى قدرتها على تحمل الملوحة وكذلك دور المعاملة بهذه العناصر فى ملاشاة الأثر الضار للملوحة .

أدت الملوحة بتركيز ٢,٥ ديسيمنز/م إلى حدوث نقص معنوى فى طول النبات ، مساحة الورقة (سم٢) للنبات ، وعدد وطول الجذور العرضية خلال موسمى النمو ، وكان تأثير الملوحة أكثر وضوحا فى الصنف الحساس مقارنة بالصنف المقاوم .

تحت كل من الظروف الطبيعية والملوحة أدت المعاملة بالعناصر الصغرى منفــردة أو متداخلة ليس فقط إلى زيادة كل صفات النمو السابقة بل إلى ملاشاة الأثر الضار للملوحة ، وكانت المعاملة بالزنك منفرداً أو خليط مع العناصر الصغرى الأخرى أفضل المعاملات فى هذا الشأن .

تشريحيا أدت المعاملة إلى زيادة قطر الساق ، سمك طبقات خلايا الأكسيودرمس ، سمك نسيج القشرة ، سمك طبقة الإندودرمس ، قطر الإسطوانة الوعائية بالإضافة إلى نقص سمك الورقة فى منطقة العرق الوسطى ، والبشرة العليا والسفلى والنسيج المتوسط وأيضاً أبعاد الحزمة الوعائية الكبيرة نتيجة لنقص سمك كل من نسيجى الخشب واللحاء . كما أدت الملوحة إلى نقــص قطــر أوعية الخشب التالى .

أدت المعاملة بالعناصر الصغرى منفردة أو متداخلة إلى زيادة كل الصفات التــشريحية السابقة . وكانت المعاملة بالزنك منفرداً أو مخلوطاً مع العناصــر الــصغرى الأخــرى أفــضل المعاملات .

ويبدو أن تكشف مجموع جذرى غزير وتكون بارنكيما التهوية فى نسيج والتكوين المبكر للإكسودرمس دور هام فى زيادة تحمل النبات للملوحة .

بصفه عامه، المعامله بالزنك تؤدى الى التغلب على التأثير السيء للملوحه علــى نمــو النبات وصفاته التشريحيه.